Risk-Based Clearance Criteria

Prepared in support of
Syracuse University's Application
under 40 CFR §761.61(c)

Bird Library Basement
Syracuse University
Syracuse, NY

Prepared by:
Anthony P. DeCaprio, Ph.D., DABT
Consultant in Toxicology and Risk Assessment
547 NW 208th Dr.
Pembroke Pines, FL 33029

October 2011
(Revised January 2012)

1.0. Background

This document provides discussion and derivation of target air and surface clearance values for polychlorinated biphenyls (PCBs) in an area within the Syracuse University Bird Library basement that has undergone renovations associated with the removal of carpeting and associated PCB-containing adhesive. Removal of carpet, the underlying adhesive and approximately 1/8th inch of underlying concrete flooring surface from 9,500 ft^2 of basement flooring (*i.e.,* the "Subject Floor" or "Basement") took place in July, 2009. Removal of an additional 1/16th inch of concrete followed by sealing of the floor surface with a densifier product took place in August, 2009.

As detailed in the body of this Application, subsequent testing of waste material generated during these activities revealed concentrations of PCBs above the USEPA 50 ppm regulatory threshold that trigger requirements under EPA's PCB regulation, 40 CFR part 761. This prompted the University to conduct a cleaning project that revealed residual PCB contamination in the Subject Floor (less than 10 ppm but greater than 1 ppm) that is the subject of this application.

This Appendix presents derivations of risk-based, site-specific clearance values for PCBs applicable to inhalation of air and dermal/ingestion exposure to surficial dust associated with the presence of PCB residual contamination in the Bird Library basement concrete floor based on a set of reasonable future exposure scenarios.

2.0. Summary of Bird Library Basement PCB Sampling Data:

Between September 2009 and July 2011, a series of floor wipes, air samples, and composite bulk concrete samples were taken at various times and locations within the area of the Subject Floor. Complete data on these sampling and analysis efforts are presented in the main Application and additional Appendices cited therein. The sections below summarize PCB sampling data in the area of the Subject Floor that are relevant to risk-based clearance value derivation.

2.1. Bulk Concrete Sampling. Samples of bulk surface concrete were taken on 11/13/2009, 9/29/2010, and 10/10/2010 at 12 locations in the Subject Floor. Cleaning of the flooring surface had occurred between each of these sampling times. Composite samples were collected using a 0.25" drill bit at a target penetration depth of 0.25". Bulk dust was collected and composited from six sampling points per location. Samples were analyzed for total PCB using USEPA Method 8082. Total PCB concentrations (as Aroclor 1254) in these samples ranged from <1.0 ppm to 8.9 ppm. These data suggest variability in surficial concrete PCB levels in the Subject Floor across location and time of sampling. However, they confirm that PCBs have migrated from the previously applied mastic material and remain at low concentrations within the concrete matrix.

2.2. Surface Wipe Sampling. Wipe samples (hexane, 10 cm × 10 cm template in accordance with USEPA guidelines) in the area of the Subject Floor were taken on 9/1/2009 (prior to cleaning of the floor) and 9/5/2009 (after cleaning) and analyzed by USEPA method 8082. Pre-cleaning values for nine sample locations ranged from below reporting limit (0.5 μg PCB/100 cm^2) to 17.8 μg PCB/100 cm^2, with two exceedances of the USEPA clearance value of 10 μg PCB/100 cm^2 for high-occupancy areas. Post-cleaning values for 12 sample locations ranged from below reporting limit to 2.0 μg PCB/100 cm^2, with no exceedance of the USEPA clearance value. Additional wipe samples were taken in January 2010 on the edges of the Subject Floor along the walls and at edges of exposed structural columns in the Basement, with values ranging from 8.0 - 91.0 μg/100 cm^2

At the request of USEPA, supplemental wipe sampling of the Subject Floor was conducted in March of 2011. One sample (out of 26) had detectable PCB, at a level of 1.5 μg/100 cm^2 (detection limit of 0.5 μg/100 cm^2). This sample was taken in an area of the Subject Floor that is off the main floor (*i.e.,* the "Nook"), which is used for temporary storage of book carts and an entryway to a storage room used by the University's Physical Plant department.

Due to the detection of PCBs in the Nook, USEPA requested that further supplemental wipe sampling be performed. On June 2, 2011, three additional wipe samples were taken, with resulting PCB detections ranging from 1.1 - 2.6 μg/100 cm^2.

2.3. Air Sampling. Air samples were taken from the Bird Library Basement quiet study area and several adjacent offices on 9/5/2009 following the supplemental cleaning activities to remove residual dust generated during the renovation project. These samples were analyzed using NIOSH method 5503 with a reporting limit of 1,000 ng/m^3 (*i.e.,* at the NIOSH REL). All samples were non-detect for PCBs.

At USEPA's request, additional air testing was conducted in June 2011 using Methods TO-10A/8082 for Aroclor-based PCB analysis, with a nominal reporting limit of 150 ng/m^3. PCBs were not detected above the reporting limit at any of the five sampling locations, including the one located in the area of the Nook.

Documentation associated with the foregoing testing is included as the Exhibits to this Application.

3.0 <u>Toxicity Values for PCBs</u>:

USEPA has developed toxicity values for cancer (*i.e.,* cancer slope factor; CSF) and non-cancer (*i.e.,* reference dose; RfD) effects of PCBs. In risk assessments, toxicity values are combined with exposure assumptions in models that predict cancer risk and non-cancer hazard associated with specific levels of contaminant in various environmental media. For derivation of site- and exposure scenario-specific target clearance or cleanup values at a particular location, the models are run in reverse to calculate air and surface PCB concentrations that correspond to acceptable levels of cancer risk and non-cancer hazard.

Acceptable cancer risk levels under USEPA policy typically range from 1 in 10,000 (1E-04) to 1 in 1,000,000 (1E-06). Non-cancer hazard is typically expressed as the ratio of average daily intake (in mg/kg-day) calculated for a particular exposure scenario to the RfD for the particular chemical. A ratio ("Hazard Index") of 1 or lower is generally acceptable for non-cancer effects.

To quantify risk from PCBs, toxicity values most applicable to the particular PCB mixture under evaluation should be selected. The PCB mixtures present in the environment and to which people are typically exposed generally differ from both the commercial Aroclor mixtures released to environmental media and from those used in studies where the toxicity values were derived.

USEPA has established a non-cancer RfD for Aroclor 1016 of 7E-05 mg/kg-day and a non-cancer RfD for Aroclor 1254 of 2E-05 mg/kg-day. USEPA has established upper-bound CSFs for lowest risk/persistence (*e.g.,* Aroclor 1016), low risk and persistence (*e.g.,* Aroclor 1248), and high risk and persistence (*e.g.,* Aroclor 1254) PCB mixtures of 7E-02, 4E-01, and 2E+00 $(mg/kg\text{-}day)^{-1}$, respectively. In the absence of clear data showing that the PCB congener profile in a particular environmental medium resembles the lower chlorinated mixtures, the more conservative values for Aroclor 1254 are typically used in risk assessments. While these values were derived for the oral route of exposure, recent USEPA models also utilize them for risk calculations for dermal and inhalation routes (see below).

4.0. Exposure Scenarios for Bird Library Basement:

In the present assessment, derivation of air and surface dust clearance criteria for the Subject Floor shall be based on an exposure scenario that reflects a building occupant who is likely to have the highest exposure. Clearance criteria for PCBs represent long-term average concentrations intended to protect occupants from adverse health effects resulting from chronic exposures.

Current and future exposed population groups for the Basement include building construction/renovation workers, college-age students, instructional faculty, library employees, and full- and part-time Library custodial and maintenance staff. It is assumed that no children will be present for any significant amounts of time under the proposed future use scenarios for the Basement. It is also assumed that construction/renovation workers would not be in direct contact with PCB containing air or building materials without appropriate personal protective equipment (PPE) and dust controls. In addition, their potential exposure time would be relatively short compared to that of other Basement occupants. Consequently, occupants likely to experience the highest exposure would potentially include students, faculty/library staff, and custodial/maintenance staff.

Exposure assumptions for each scenario are discussed below and summarized in Table 4.1.

4.1. Student exposure scenario. The current primary use of the Basement is quiet student study space. During semester weekdays, the area is open to student use 24 h/day, while on weekends the area is open approximately 12 h/day. Student use of the area, based upon daily head counts, varies widely during the semester, but peaks just preceding and during final exam week.

Quantitative student time use data are not available for this area of the Library. However, conservative estimates of average student time spent in the Library can be made from some available survey information, qualitative impressions of Bird Library staff, and reasonable assumptions. For example, a recent published study indicated a mean value of 14 h/week study time (*i.e.,* time spent on academic activities outside of the classroom) as an average for U.S. college/university students (Babcock and Marks, 2010). A reasonable conservative assumption is that 50% of this time (*i.e.,* 7 h/week) might be spent in library study, with the remaining in non-library locations (*e.g.,* dorm room or residence). This value would be within the upper range of data from a recent study of 205 undergraduates at a U.S. university that reported a mean of 3.7 ± 6.9 h/week spent in the campus library (Grimes and Charters, 2000). A second reasonable assumption is that library study time typically doubles during the final two weeks of the semester. Thus, an average student's time spent in the library during a typical semester would be 7 h/week for 14 weeks plus 14 h/week for 2 weeks, for a total of 126 h/semester or 252 h/year. This represents a fraction of 0.029 of total available time for a full year (252 h/year ÷ 8,760 h/year).

Future planned use of the Basement area now employed for quiet study include the construction of two new classrooms, a "feature lounge", and an open reading section. While the schedules of use for each facility have not yet been determined, reasonable assumptions can be made for purposes of exposure assessment. Estimates of average student time spent in the open reading section, based on anticipated similar use patterns as for the current quiet study area, would be identical to those calculated above, *i.e.,* 252 h/year. A conservative estimate of average student Basement future classroom use is one 3-credit course per year, or a total of 2.5 h/week of classroom time (*e.g.,* three 50-min classes per week). Due to the large amount of alternative classroom space available across campus, this value is likely to overestimate student use of a future library classroom and is thus a conservative assumption.

Based on these values, an average student's time spent in a Basement classroom during one semester would be 2.5 h/week for 14 weeks, plus 2 h for a final exam assumed to be held in the same room, for a total of 37 h/year. This represents an occupancy fraction of 0.004 of total available student time for a full year (37 h/year ÷ 8,760 h/year). When added to the assumed typical student's study time in the Basement open reading section, a total fractional time occupancy factor of 0.033 is calculated.

4.2. Library staff and instructional faculty exposure scenarios. Current use of the Basement space by Library staff consists of very short-term occupancy associated with access to offices located outside of the study space and occasional staff use for purposes of head counts and other administrative activities. For these scenarios, potential PCB exposure is assumed to be negligible as compared to other contributors to total exposure.

Following the proposed renovations of the Basement, this negligible exposure scenario is expected to continue for general library staff. However, it is also expected that teaching faculty/instructional staff would occupy these classrooms on a variable basis. A conservative estimate for such teaching time for typical faculty is a total of two 3-credit courses per semester in future Basement classroom space. Under this scenario, an average instructor's time spent in class during each semester would be 5 h/week for 14 weeks, for a total of 140 h/year. This represents a fraction of total time spent in Basement space of 0.016 for a full year (140 h/year ÷ 8,760 h/year).

4.3. Custodial/maintenance staff exposure scenario. Custodial and maintenance staff in the Bird Library currently work an 8.5 h/day shift, which includes a 30-min lunch and two 15-min breaks. Consequently, total working time is 7.5 h/day.

A very conservative assumption for risk assessment purposes under a future use scenario for the Library Basement would be that such employees would spend the entire 7.5 h/day working within the Basement area. Assuming a typical 5-day/week schedule year-round with a two week vacation, this conservative exposure scenario yields an estimated total work time for such an employee of 1,875 h/year, representing a fraction of total time spent in Basement space of 0.214 for a full year (1,875 h/year ÷ 8,760 h/year).

More realistic exposure scenarios based upon current work schedules for day and night/weekend custodial staff in the Bird Library yield lower estimates for total work time within the Basement area. For example, day shift custodial staff typically work 2 or 2.5 h/day (during instructional and exam weeks, respectively), 5 days/week, performing trash pickup and general cleaning, and 2 h/week wet mopping floors over 50 weeks/year. These values yield a total work time within the Basement of 610 h/year, representing a fraction of total time of 0.070 (610 h/yr ÷ 8,760 h/year). Current Basement occupancy schedules for 2nd shift and night/weekend custodial workers yield still lower exposure estimates. Assumptions for the various custodial/maintenance exposure scenarios are detailed in Table 4.1.

Table 4.1: Exposure Scenarios and Assumptions for Bird Library Basement Area.

Scenario	Exposure Assumptions[a]
Current student use	Study time: 7 h/week for 14 weeks plus 14 h/week for 2 weeks (exam weeks) per semester; 2 semesters per year.
Current Library staff use	Very short term occupancy for access to offices located outside of the quiet study and occasional staff use for administrative activities.
Current custodial/maintenance use (day shift)[b]	2.4 h/day, 5 days/week for 46 weeks plus 2.9 h/day, 5 days/week for 4 weeks (study/exam weeks).
Current custodial/maintenance use (2nd shift)[c]	1.5 h/day, 5 days/week for 46 weeks plus 2.0 h/day, 5 days/week for 4 weeks (study/exam weeks).
Current custodial/maintenance use (night shift)[d]	1.75 h/day, 5 days/week for 46 weeks plus 2.25 h/day, 5 days/week for 4 weeks (study/exam weeks).
Current custodial/maintenance use (weekend)[e]	1 h/day, 2 days/week for 46 weeks plus 1.5 h/day, 2 days/week for 4 weeks (study/exam weeks).
Future student use	Classroom time: 2.5 h/week for 14 weeks plus 2 h final exam per semester; 2 semesters per year. Study time: 7 h/week for 14 weeks plus 14 h/week for 2 weeks (exams) per semester; 2 semesters per year.
Future instructional staff use	5 h/week for 14 weeks plus 4 h final exams per semester; 2 semesters per year.
Future custodial/maintenance use	7.5 h/day for 250 days/year

[a] Assumes 14 weeks of classes plus two weeks for study days/final exams per semester for students/instructional staff; 50 weeks per year worked for custodial staff.
[b] Assumes 2 h/day spent in daily trash pickup (extra 0.5 h/day added for study/exam weeks) and 1 h wet mopping/sweeping twice per week.
[c] Assumes 1.5 h/day spent in daily trash pickup (extra 0.5 h/day added for study/exam weeks).
[d] Assumes 1.75 h/day spent in daily trash pickup (extra 0.5 h/day added for study/exam weeks).
[e] Assumes 1 h/day spent in daily trash pickup (extra 0.5 h/day added for study/exam weeks).

5.0. <u>Derivation of PCB Clearance Values for Bird Library Basement - Indoor Air</u>:

5.1. USEPA Exposure Estimation Tool. USEPA provides a spreadsheet (PCB Exposure Estimation Tool; USEPA, 2009a) by which total human exposure to PCBs from a range of sources can be estimated. Default input values for background PCB intake (*e.g.,* from diet, ingestion of dust and soil, inhalation, etc.) and other variables relevant to exposure assessment (*e.g.,* body weight, breathing rate, time spent indoors and outdoors, etc.) are utilized in the model. These default values were derived from published literature and other information sources.

The tool is designed specifically for calculation of exposure within a school or other public indoor environments and allows for modification of default input values to incorporate site-specific parameters to more accurately reflect a particular exposure scenario or subject group. The output of the model is a value for total daily dose (in ng/kg-day) of PCBs from all sources, which can then be compared to relevant toxicity guidance values to identify exceedances under a particular exposure scenario.

USEPA employs the RfD of 20 ng/kg-day for the commercial PCB mixture Aroclor 1254 as their default non-cancer toxicity guidance value. This approach is based on the Agency's assumption that Aroclor 1254 was the primary mixture formerly used in PCB-containing building materials such as caulks and sealants. Based on the default inputs to the model and standard age-specific inhalation rates, the USEPA model also calculates the concentration of PCBs in indoor air that would result in a total PCB intake equal to or less than the RfD for Aroclor 1254 (*i.e.,* the level "likely to be without an appreciable risk of adverse effects over a lifetime"). Target air concentrations are provided for a typical subject in several age groups.

5.2. Site-specific clearance calculations for Indoor Air. Calculation of the clearance values for air in the Bird Library Basement in this assessment employs the USEPA Exposure Estimation Tool with site-specific parameters incorporated. Table 5.1 provides a summary of assumed exposure parameters for the conservative exposure scenarios discussed above. The scenario for hypothetical custodial/maintenance worker was chosen as the most conservative for air clearance value calculation, based on the highest value for Fttis (*i.e.,* 0.214) in this group.

For purposes of this calculation, all of the USEPA default input parameters for the "adult" age group (≥19 years of age; as appropriate for college students, staff, and faculty) are unchanged, with the exception of the values for EFs (exposure frequency in school) and ETsi (indoor time at school), which are reflected in the final Fttis value input to the model. As discussed above, custodial/maintenance staff are assumed to work full-time in the Bird Library Basement 7.5 h/day, 5 days/week, for 50 weeks/year. Consequently, values of 7.5 h/day and 250 days/year were input for EFs and ETsi,

Table 5.1: Summary of Bird Library Basement Exposure Parameters and Calculated Air Clearance Values.

Scenario	Total h/year	Fttis[a]	Clearance Value (ng/m^3)[b]
Current student	252	0.029	2,603
Current staff	negligible	-	-
Current custodial (day shift)	610	0.070	1,083
Current custodial (2nd shift)	385	0.044	1,718
Current custodial (night shift)	448	0.051	1,483
Current custodial (weekend)	104	0.012	6,282
Future student	289	0.033	2,289

Future instructional faculty	140	0.016	4,720
Future custodial	1,875	0.214	359
USEPA default[c]	1,489	0.170	450

[a] fraction of total time (over a year) spent indoor at school (unitless); see above for derivation of these values.
[b] target value in ng/m^3 calculated using USEPA Exposure Estimation Tool, based on the RfD for Aroclor 1254.
[c] based on 8.0 h/day, 185 days/year.

respectively. These values contrast with the default USEPA parameters of 8 h/day and 185 days/year for adult staff in school. Use of the site-specific values in the USEPA model yields a value of 359 ng/m^3 as the target clearance value for custodial/maintenance workers in the Bird Library Basement future use scenario. This site- and scenario-specific air level represents a highly conservative value that would be associated with minimal risk according to USEPA guidelines.

Although the USEPA model focuses on non-cancer hazard, additional calculations indicate that the proposed target clearance value of 359 ng/m^3 for Bird Library Basement is also protective for cancer risk. By assuming standard values of 70 kg for adult body weight and 20 m^3/day for adult inhalation rate, the upper-bound CSF for Aroclor 1254 of 2E+00 (mg/kg-day)$^{-1}$ can be converted into an Inhalation Unit Risk (IUR) of 6E-07 (ng/m^3)$^{-1}$. Input of this IUR, the target air clearance value, and the site-specific exposure values discussed previously into a standard inhalation risk equation yields the following calculation:

$$Risk = \frac{359\ ng/m^3 \times 250\ days/yr \times 25\ yr \times 7.5\ h/day \times 6\text{E-}07\ m^3/ng}{25{,}550\ days \times 24\ h/day} = 2\text{E-}05$$

Alternatively, since the target air clearance value corresponds to a total PCB intake rate of 20 ng/kg-day (*i.e.,* the RfD for Aroclor 1254), one can calculate cancer risk by combining the intake rate with the upper-bound CSF for Aroclor 1254 as follows:

$$Risk = 20\ ng/kg\text{-}day \times 2\ kg\text{-}day/mg \times 1\text{E-}06\ mg/ng = 4\text{E-}05$$

Both of these calculated cancer risk values are within the acceptable cancer risk range under current USEPA policy.

6.0. <u>Derivation of PCB Clearance Values for Bird Library Basement - Surface Dust</u>:

6.1. USEPA World Trade Center Dust Exposure Model. In support of World Trade Center (WTC) investigations following the 9/11/2001 attacks in Lower Manhattan, USEPA developed a model for calculating total exposure to various contaminants of concern, including PCBs, potentially released to the environment following collapse of the WTC buildings (USEPA, 2003). While the model focuses on exposure to contaminants in settled surface dust via dermal contact and ingestion in residential settings, it can be adapted to other exposure scenarios by appropriate modification of input parameters.

The WTC model calculates cancer risk and non-cancer hazard associated with specific dust exposure scenarios in addition to deriving target clearance values for acceptable levels of risk and/or hazard. The model is quite complex and incorporates numerous exposure medium-, age-, and subject-specific parameters and assumptions that contribute to uncertainty in the calculations. Major inputs include transfer percentages and coefficients from hard and soft surfaces, exposure times for hard and soft surfaces, dermal absorption fraction, subject body weight and age, hand-to-mouth transfer factors, saliva extraction efficiency, and rate constants for dissipation of the contaminant over time.

For PCBs, a target value of 0.16 $\mu g/100\ cm^2$ was derived as the clearance value for surface dust under a residential exposure scenario. This value was based on a non-cancer hazard index of 1; the corresponding cancer risk level associated with this target surface dust PCB concentration was calculated as 3E-06.

At the suggestion of USEPA, this model was employed to calculate clearance values for surface dust in the Basement under the custodial/maintenance worker exposure scenario discussed above. The following section discusses the rationale for selecting site- and scenario-specific inputs to the model.

6.2. Inputs to WTC Surface Dust Exposure Model. For the present assessment, USEPA default values for adult subjects were retained for several input parameters. These defaults are presented in the documentation to the WTC model (USEPA 2003; Appendix D). These include Fraction Transferred from Surface to Skin for hard surfaces ($FTSS_{hard}$; 0.25), Dust Surface Load (DSL; 50 $\mu g/cm^2$), body weight (71.8 kg), averaging time for cancer risk (70 years), mouthing area (45 cm^2), and Saliva Extraction Factor (SE; 0.5). Acceptable cancer risk and non-cancer hazard index also employ the values adopted by USEPA, *i.e.,* 1E-04 and 1, respectively. Other factors were modified as discussed below.

6.2.1. Transfer factors and contact time for hard vs. soft surfaces. USEPA utilizes factors specific to both hard and soft surfaces in the WTC model. The latter would include carpeted flooring. The assessment for the Basement assumes that all surfaces subject to dermal contact are hard surfaces. This assumption is appropriate for an initial analysis, since the final configuration of the classrooms in the Subject Area is not yet known and may or not include substantial carpeting.

As the USEPA default transfer factor (FTSS) for dust from hard surfaces (0.25) is higher than that from soft surfaces (0.05), this assumption is also conservative. Consequently, the Bird Library custodial/maintenance exposure scenario assumes that employees will spend 7.5 h/day on hard surfaces and no time on soft surfaces within the Basement. This contrasts with the USEPA default of 8 h/day and 4 h/day on hard and soft surfaces, respectively, for a residential exposure scenario.

6.2.2. Subject age range. The current assessment assumes adult (18+ years) age for all custodial/maintenance workers. Consequently, exposure estimates remain constant across all years of exposure in this assessment. The USEPA default utilizes age-specific factors beginning at age 1.

6.2.3. Exposure duration. Exposure duration (ED) is assumed to be 25 years, which is an upper bound estimate for work tenure that is commonly applied in USEPA site-specific risk assessments. The USEPA default for the WTC model assumes exposure for 30 years, based on upper bound estimates of time spent in a residence.

6.2.4. Exposure frequency. Exposure frequency (EF) is set at 250 days/year based on a 5 day/week, 50 day/year work schedule for Bird Library custodial employees, as compared to the USEPA residential default EF of 365 days/year.

6.2.5. Transfer coefficient. This parameter (TC) reflects the rate of exposed skin area contact with dust contaminated surfaces, with units of cm^2/h. It is calculated from FTSS, exposed skin area (SA), ET, DSL, and daily skin load. The USEPA default value of 1,200 cm^2/hr for TC in adults assumes SA of 9,000 cm^2 based on an assumption that 50% of the adult skin area is available for dermal contact with hard and soft surfaces. This value is overly conservative and not reasonable for occupational settings. For the present assessment, it is assumed that available skin area would include the exposed hands and forearms of custodial/maintenance workers, with all other areas of the torso and extremities covered by work clothing.

A value of 2,550 cm^2 for SA is used in the Basement calculations, based upon recent USEPA data for combined forearm and hand areas of adults (USEPA, 2009b). A site-specific TC is calculated according to the following formula derived from that presented in Appendix D of the USEPA WTC Report (USEPA, 2003):

$$TC = \frac{Daily\ Skin\ Load \times SA}{(ET_{hard} \times FTSS_{hard} \times DSL_{hard})}$$

Substituting a value of 9 μg/cm^2-day for daily skin load (as employed in the USEPA derivations) yields a site-specific value of 245 cm^2/h for TC as follows:

$$TC\ (cm^2/h) = \frac{9\ \ (\mu g/cm^2 \cdot day) \times 2550\ (cm^2)}{7.5\ (h/day) \times 0.25 \times 50\ (\mu g/cm^2)} = 245\ (cm^2/h)$$

6.2.6. Mouthing frequency. For estimation of exposure via dust ingestion, assumptions are necessary regarding the frequency of hand-to-mouth transfer (FQ) of dust. For the WTC model, USEPA assumes age-specific values for FQ ranging from 9.5 events/h for 1-6 years of age to 1 event/h for adults. A value of 3 events/day (0.4 events/h) for FQ was assumed for Basement workers in this assessment as a reasonably conservative value for occupational settings. This value is similar to those adopted in recent published derivations of occupational surface dust clearance values using an approach similar to that of USEPA (May et al., 2002; Kuusisto et al., 2007).

6.2.7. Dermal absorption fraction. Literature values for the percentage of dermally applied PCBs ultimately absorbed via the skin vary substantially, as do recommended USEPA defaults for this parameter. The USEPA WTC Report (USEPA, 2003) utilized a value of 14% (0.14) for dermal absorption, based on a study by Wester (1993) that investigated percutaneous absorption of PCBs from soil. However, more recent work with Aroclors in animal and *in vitro* human skin models have demonstrated lower absorption fractions. The USEPA Exposure Estimation Tool for air calculations

(USEPA, 2009a) employs a dermal absorption fraction of 7% (0.07) for PCBs from indoor dust as a consensus value derived from several published studies (Roy et al., 2009). This value is therefore utilized in the present assessment to calculate PCB dose via dermal contact with surface dust.

6.2.8. Dissipation factor. The USEPA WTC model includes a parameter to reflect potential loss of contaminants from dust over the 30-year period of residential exposure, as a result of volatilization, dilution with uncontaminated dust, and surface cleaning. Inclusion of such a parameter is clearly appropriate for a scenario that assumes a contaminant source associated with release from a single event in time (such as the WTC collapse) followed by a return to baseline conditions. USEPA adopted a dissipation rate constant (k) of 0.38 year^{-1} for the WTC model, based on data demonstrating a half-life of 20-22 months for dioxin in contaminated building studies.

In contrast, for a scenario involving potentially extended release from a contaminated source in place (such as PCBs contained in a concrete floor), selection of an appropriate dissipation factor is more complicated. Nevertheless, it is plausible that PCBs in the concrete matrix could migrate to the floor surface and be removed by volatilization and/or physical cleaning. In addition, some PCB, over time, could diffuse deeper into the concrete matrix, thereby becoming less available for potential human exposure. While there are currently no data with which to model the kinetics of these processes, a conservative estimate of PCB dissipation for the Basement exposure scenario may nevertheless be reasonable.

The present analysis provides surface dust clearance values calculated using two conservative assumptions; 1) that significant dissipation of source PCB does not occur (*i.e.,* k = 0 year^{-1}), and 2) that dissipation occurs at 10% of the rate calculated for the WTC residential scenario (*i.e.,* k = 0.038 year^{-1}).

6.3. Site-Specific Clearance Calculations for Surface Dust. Calculation of clearance values for PCBs in surface dust in the Basement in this assessment employs the USEPA WTC model with default and site-specific parameters incorporated as described above. The calculation spreadsheets are provided as an Attachment.

Table 6.1 summarizes dermal contact and dust ingestion PCB doses, calculated cancer risk, and calculated hazard index for models assuming either no dissipation or dissipation at 10% of the rate employed for the WTC residential exposure calculations. As can be seen, clearance values of 3.1 µg PCB/100 cm^2 and 4.9 µg PCB/100 cm^2 result in an acceptable cancer risk level (*i.e.,* <1E-04) and non-cancer hazard index (*i.e.,* ≤1.00E+00) in the no dissipation and dissipation models, respectively.

Table 6.1: WTC Surface Dust Model Results.

Cancer Risk[a]					
Surface Dust PCB (µg/100 cm^2)	**k[b] ($year^{-1}$)**	**Dermal LADD[c] (ng/kg-day)**	**Ingestion LADD (ng/kg-day)**	**Total LADD (ng/kg-day)**	**Risk**
3.1	0	3.49E+00	3.66E+00	7.15E+00	1.43E-05
4.9	0.038				
Non-cancer Hazard[d]					
Surface Dust PCB (µg/100 cm^2)	**k ($year^{-1}$)**	**Dermal ADD[e] (ng/kg-day)**	**Ingestion ADD (ng/kg-day)**	**Total LADD (ng/kg-day)**	**Hazard Index**
3.1	0	9.76E+00	1.02E+01	2.00E+01	1.00E+00
4.9	0.038				

[a] Based on upper-bound CSF for Aroclor 1254 of 2E-06 $(ng/kg\text{-}day)^{-1}$.
[b] Dissipation rate constant.
[c] Lifetime Average Daily Dose.
[d] Based on RfD for Aroclor 1254 of 2E+01 ng/kg-day.
[e] Average Daily Dose.

7.0. Discussion and Conclusions:

Many uncertainties are inherent in the process of human health risk assessment, mainly due to the reliance on numerous assumptions that may lack comprehensive data with which to support the choice of specific values as inputs to risk assessment models. The wide range of "acceptable" values for many of these parameters is illustrated in regulatory agency guidance documents (USEPA, 2009b) and in published literature (May et al., 2002; Kuusisto et al., 2007). These uncertainties are particularly large for routes of exposure that require complex adjustments for uptake and/or absorption, such as inhalation and dermal contact.

USEPA has developed specialized tools for calculating risk-based guidance values for PCBs in indoor air (PCB Exposure Estimation Tool; USEPA, 2009a) and for a variety of contaminants in surface dust (USEPA, 2003). Uncertainties in the input parameters used in these models are noted and discussed in the documentation for these models. Because of these uncertainties, assumptions regarding various input values for the models are conservative; this conservatism becomes amplified when many such input parameters are required in a particular risk model. Consequently, there is a high probability that "clearance" values generated using these models will not underestimate, and, in fact, are likely to significantly overestimate risks associated with a specific exposure scenario.

It must be understood that risk-based guidance values for PCBs generated using either of the USEPA models employed in the present assessment are based on a requirement for long-term, cumulative exposure to these contaminants. Therefore, the proper use of these values is as a trigger for additional investigation and evaluation should they be exceeded. In contrast, their potential application as "action levels" to initiate immediate or emergency responses in the short term is clearly inappropriate and unsupported.

Levels of PCBs determined in samples of surface dust and air within the Bird Library Basement appear to be very low in comparison to those reported in buildings with significant PCB contamination. The majority of wipe samples taken in the Basement have been either non-detect or below the 10 µg/100 cm^2 PCB standard for non-porous surfaces in high occupancy areas that is employed in 40 CFR 761.61(a) (the self-implementing cleanup option for PCB remediation waste). In particular, the lack of detectable PCBs above the 150 ng/m^3 reporting limit in air samples taken within the Basement is strongly indicative of a lack of impact to the indoor air exposure medium. Based on these data, it can be concluded with a high level of confidence that current exposure conditions within the Basement do not pose an unreasonable health risk to students, staff, and employees.

Table 7.1 summarizes risk-based clearance values calculated using the USEPA risk-based models and reasonably conservative, site-specific exposure assumptions for the Basement. They represent air and surface dust concentrations that would be associated with minimal risk according to USEPA guidelines and are therefore appropriate for use as target values for future monitoring within the Basement.

For air as the exposure medium, the calculated value of 359 ng/m^3 is lower than the USEPA default value of 450 ng/m^3 for adult staff in school settings, due primarily to the larger estimated yearly occupancy time for Bird Library custodial/maintenance staff.

For surface dust as the exposure medium, two values were generated, one (3.1 µg/100 cm^2) based on a very conservative assumption of no dissipation of PCBs, and another (4.9 µg/100 cm^2) assuming a slow dissipation rate constant of 0.038 $year^{-1}$. It is highly likely that a clearance value within this range would be associated with no unreasonable risk to Library occupants under the conservative exposure scenarios chosen for analysis. Therefore, as a reasonably conservative compromise, it is proposed that the midpoint value of this range (*i.e.,* 4.0 µg/100 cm^2) be selected as the clearance value for surface dust in the Bird Library Basement area.

The clearance values calculated herein are based on an exposure scenario that reflects a building occupant who is likely to have the highest potential exposure. These values represent long-term average concentrations intended to protect occupants from adverse health effects resulting from chronic exposures. Therefore, in future monitoring efforts, they are appropriately compared to a metric representing the mean rather than maximum concentration detected. Under established USEPA guidance, the metric commonly selected for this purpose is the 95% upper confidence limit (95% UCL) of the mean (USEPA, 2001, 2002).

Table 7.1: Summary of Risk-Based Clearance Values for Bird Library Basement.

Medium	Clearance Value
Air	359 ng/m^3
Surface Dust	3.1 µg/100 cm^2 (model with no dissipation) 4.9 µg/100 cm^2 (model with dissipation) 4.0 µg/100 cm^2 (midpoint of range)

8.0. <u>References</u>:

Babcock, P. and Marks, M. (2010). The falling time cost of college: Evidence from half a century of time use data. *National Bureau of Economic Research Working Paper No. 15954.*

Grimes, P.W. and Charters, M.F. (2000). Library use and the undergraduate economics student. *College Student Journal* **4**, 557-571.

Kuusisto, S., Lindroos, O., Rantio, T., Priha, E., and Tuhkanen, T. (2007). PCB contaminated dust on indoor surfaces - Health risks and acceptable surface concentrations in residential and occupational settings. *Chemosphere* **67**, 1194-1201.

May, L.M., Gaborek, B., Pitrat, T., and Peters, L. (2002). Derivation of risk based wipe surface screening levels for industrial scenarios. *Sci.Total Environ.* **288**, 65-80.

Roy, T.A.; Hammerstrom, K.; Schaum, J. (2009). Percutaneous absorption of 3,3',4,4'-tetrachlorobiphenyl (PCB 77) from soil. *J.Toxicol.Environ.Health A*. **72**, 350-357.

USEPA (2001). Risk Assessment Guidance for Superfund (RAGS) Volume III – Part A: Process for Conducting Probabilistic Risk Assessment, Chapter 5: Probabilistic Risk Assessment and Preliminary Remediation Goals; EPA 540-R-02-002, December.

USEPA (2002). Calculating Upper Confidence Limits for Exposure Point Concentrations, OSWER 9285.6-10, December.

USEPA (2003). World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks.

USEPA (2009a). PCB Exposure Estimation Tool, Version 1.1 (PCBs-SchoolDose_10-2-09-v1.xls).

USEPA (2009b). Exposure Factors Handbook: 2009 Update (Review Draft). EPA/600/R-09/052A, July.

Wester, R.C., Maibach, H.I., Sedik, L., Melendres, J., and Wade, M. (1993). Percutaneous absorption of PCBs from soil: In vivo rhesus monkey, in vitro human skin, and binding to powdered human stratum corneum. *J.Toxicol.Environ.Health* **39**, 375-382.